an aperient on the fifth, the parts having entirely closed. The patient was well and about in a month. The plan of immediate suturing the perineum in cases of rupture is rapidly coming into favour as the true method of treatment.

R. P. H.

ART. XXII.—*On the Source of Muscular Power: Arguments and Conclusions drawn from Observations upon the Human Subject under Conditions of Rest and of Muscular Exercise.* By AUSTIN FLINT, Jr., M.D., Prof. of Physiology and Physiological Anatomy in the Bellevue Hospital Medical College, New York, etc. 12mo. pp. 103. New York: D. Appleton & Co., 1878.

SINCE Dr. Mayer, in 1842, first indicated the physiological relations of the great discoveries of Joule, Helmholz, and Grove in the domain of physics, physiologists have earnestly sought to explain the hitherto incomprehensible phenomena of living beings by purely chemical and physical laws.

It is now taught in many quarters that the forces and laws of inorganic nature offer a ready and sufficient explanation of all the subtile processes of organic life. The simplicity and positiveness thus introduced into the study of vital phenomena has a charm which is very seductive; and if the hypothesis were only proven it would mark an era in the history of physiology the importance of which can scarcely be realized. The investigations on the source of muscular power, which are recorded in the *brochure* before us, are largely responsible for the materialistic tendencies of modern physiology. It is therefore fortunate that Dr. Flint, who is so justly eminent as a physiologist, and who has been one of the principal original investigators of the question at issue, should enter the following emphatic protest against this tendency:—

> "Taking nature as she now appears to us, there seems to be little or no basis for what may be termed an immaterial physiology. The researches which I have made into the question of the source of muscular power are not in any way opposed to the known relations between matter and force; they have been directed simply toward the solution of the problem whether the food be concerned directly, by its transformations, in the production of muscular power, or whether muscular effort involve changes in the muscular substance itself, this substance being destroyed as muscular tissue, discharged from the body in the form of excrementitious matter, and the waste being repaired by food."

The present essay was originally printed in the *Journal of Anatomy and Physiology* (Oct. 1877); and now, with many typographical corrections and some additional matter, appears in its present neat and attractive form.

The relation of food to animal work forms one of the very interesting and important chapters in physiology, for, aside from the purely scientific interest of the problem, its solution must exercise a vast practical influence upon the question of alimentation in health and disease.

Until recently, the well-known theory of Liebig, enunciated nearly forty years ago, has stood unquestioned; however, when the reactionary wave set in, it rolled rapidly to the other extreme, and Traube, with other German physiologists, have advanced a theory directly opposed to that of Liebig, *i. e.*, that the nitrogenous constituent of muscle is not destroyed in its action, but that the force is wholly due to the oxidation of non-nitrogenous matter, converted, through the mechanism of the muscular system, into motor power.

I believe the new doctrine of the source of muscular power numbers among its supporters nearly all of the prominent foreign physiologists; in this country, however, the tide of opinion in its favour was early arrested by the publication of the thoroughly scientific experiments of our author made upon the pedestrian Weston in 1870. These experiments, which are analyzed in the volume before us, were the first, according to Dr. Flint, in which was adopted the method of investigating the influence of exercise upon the excretion of nitrogen by comparing the nitrogen eliminated with the nitrogen of food.

The attention of the profession was first permanently directed to the question under discussion in 1866 by Profs. Fick and Wislicenus, in their famous ascent of the Faulhorn, one of the Bernese Alps. These distinguished observers, though their experiment lacked that scientific precision necessary for the establishing of a great truth, assumed to have proven that the muscular system is a machine consuming in its work not its own substance, but fuel which is supplied chiefly by the hydro-carbonaceous articles of food. Of the many physiologists who have participated in the discussion, the two most prominent ones, representing opposite sides of the controversy as they do different continents, are Profs. Pavy, of London, and Flint, of New York. More than one-half of the little volume before us is devoted to a discussion of the experiments of these two observers upon Weston during certain of his celebrated pedestrian feats. In both series of experiments the proportion of nitrogen eliminated to that ingested during rest and during extraordinary exercise was ascertained, although Pavy failed to include in his estimate the nitrogen of the feces, which Flint considers an important omission. Both experimenters found an increase of nitrogen eliminated over that ingested during the days of walking, but the interpretation of this increase leads Drs. Pavy and Flint to very different conclusions.

We cannot, for want of space, give the figures and calculations of our author, but Dr. Flint plainly shows that by either method of calculation a large discrepancy exists between the amount of work actually performed and that which can be accounted for either by estimating the force-value of the muscle actually consumed, represented by the nitrogen excreted, or the force-value of the food taken. In the one case (Pavy) the excess amounted to over eleven per cent. of the work actually done, while in the other (Flint) the work accomplished was more than ten times the estimated force-value of nitrogenized food and muscle consumed, deducting the force used in internal work (respiration, circulation, secretion, etc.). This discrepancy is only explicable on the assumption that serious errors exist both in the measurement of the force produced and in the calculation of the force-value of matters consumed. In speaking of the data upon which these calculations are based, Dr. Flint says:—

> "The reduction of level miles walked to foot-tons is inaccurate; an accurate estimation of the force used in circulation, respiration, etc., seems at present impossible; and the assumption that the force-value of nitrogenized food, calculated by reducing heat-units developed by burning the food in oxygen to foot-tons, can be applied absolutely to the changes which food undergoes in the human body, has no argument in its favour drawn from experimental facts. Still, no one can say that matter can be actually destroyed, that matter can undergo certain chemical changes without the development of force, or of heat which represents force, or that force can be developed in the body without some change in matter. My only argument is, that purely physical laws cannot as yet be applied absolutely to the operations of the living organism."

Dr. Flint strongly and repeatedly insists, in the body of the essay, upon the danger of relying too implicitly upon the method adopted by Pavy, Haughton, and others for estimating in foot-tons the force used in circulation, respiration, and the production of animal heat.

When we recall the fact that the estimates of different observers of authority present variations of more than one hundred per cent., we fail to see how an unprejudiced mind can refuse to accept the author's conclusion: "I cannot see how we can avoid banishing, for the present at least, these uncertain and erroneous processes from physiological research, as applied to the theories of muscular action and the source of muscular power."

The essay concludes with a full and very excellent *résumé* of the argument in the text, which our limited space alone prevents us quoting in full. In justice to the reader, however, we cannot omit the following closing paragraph:—

> "IX. Finally, experiments upon the human subject show that the direct source of muscular power is to be looked for in the muscular system itself. The exercise of muscular power immediately involves the destruction of a certain amount of muscular substance, of which the nitrogen excreted is a measure. Indirectly, nitrogenized food is a source of power, as, by its assimilation by the muscular tissue, it repairs the waste and develops the capacity for work; but food is not directly converted into force in the living body, nor is it a source of muscular power, except that it maintains the muscular system in a proper condition for work. In ordinary daily muscular work, which may be continued indefinitely, except as it is restricted by the conditions of nutrition and the limits of age, the loss of muscular substance produced by work is balanced by the assimilation of alimentary matters. A condition of the existence of the muscular tissue, however, is, that it cannot be absolutely stationary, and that disassimilation must go on to a certain extent, even if no work be done. This loss must be repaired by food to maintain life. A similar condition of existence applies to every highly organized part of the body, and marks a broad distinction between a living organism and an artificially constructed machine, which latter can exert no motive power of itself, and can develop no force that is not supplied artificially by the consumption of fuel or otherwise."

In order to meet the objections which might be urged by some, that he had failed to include in his calculations the heat-producing and force-producing power of the non-nitrogenous food taken during the walk, Dr. Flint, in a short appendix, supplies this omission.

In the experiments made on Weston in 1870, the quantity of non-nitrogenous food consumed was carefully weighed. Calculating the force-value of both the nitrogenous and non-nitrogenous matters used, and adding the force-value of his loss of weight, the aggregate represents the sum of the forces with which Weston was to accomplish his pedestrian feat and maintain circulation, respiration, etc. This calculation, however, fails to account for the muscular work actually performed in walking the three hundred and seventeen and one-half miles in five consecutive days. There is still a deficiency of more than ten per cent. which cannot be accounted for, and which shows, according to our author, "the fallacy of such estimates, and the impossibility of accounting for muscular work actually performed, even when we include the heat-value and the force-value of non-nitrogenized food."

In closing our imperfect notice of this monograph, we cannot commend it too highly as an important contribution to the literature of the subject of which it treats. It deserves, and doubtless will receive, a warm reception from the profession.

W. J. C.

ART. XXIII.—*Albrecht von Graefe: Sein Leben und Werken.* Von Dr. EDUARD MICHAELIS, Augenarzt in Berlin. Berlin: Druck und Verlag von G. Reimer. pp. 196, 1877.

Albrecht von Graefe: His Life and Works. By Dr. EDWARD MICHAELIS.

IT is now eight years since von Gräfe died, and this small volume is the first effort to acquaint the world at large with the notable events of his private life,